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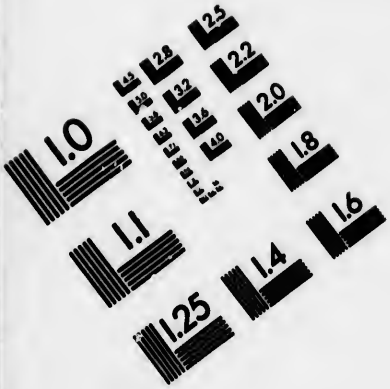

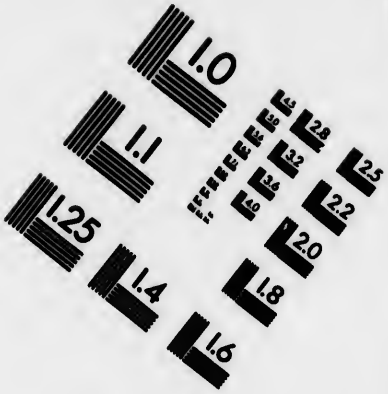

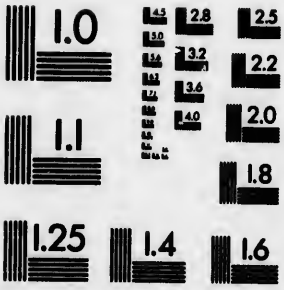

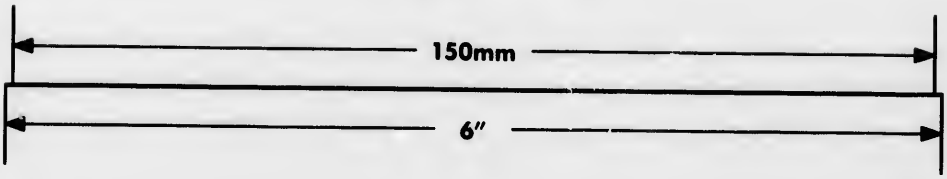

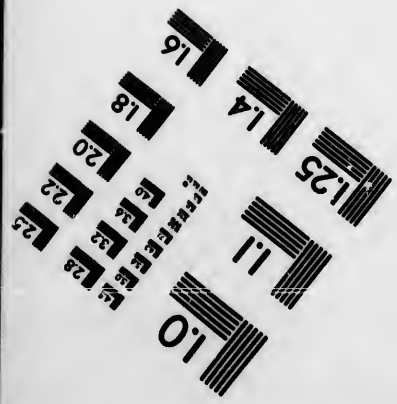

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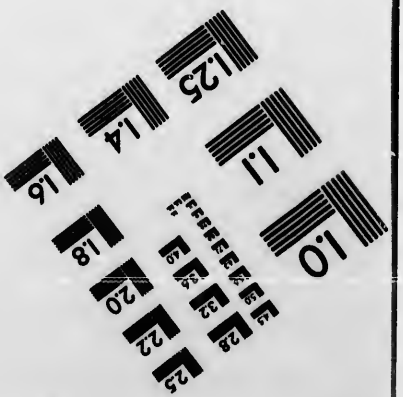

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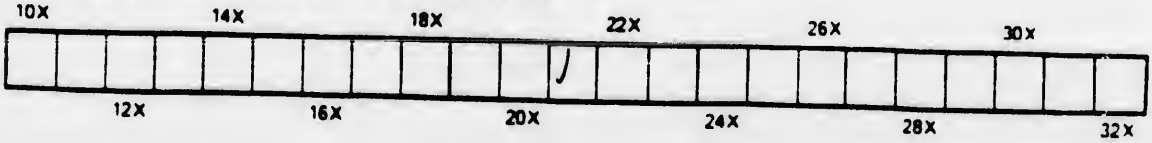

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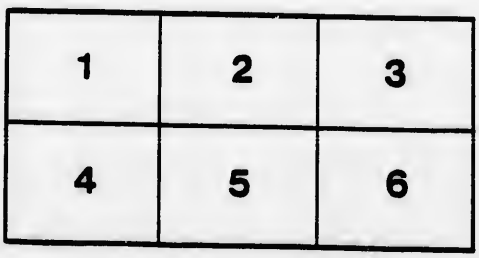

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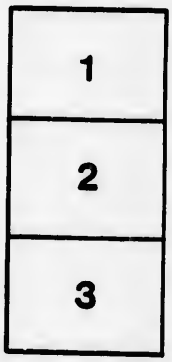

ONTARIO DEPARTMENT OF AGRICULTURE

TORONTO FEBRUARY, 1893.

BULLETIN (SPECIAL.)

THE MAKING OF ROADS.

PREPARED BY JAMES A. BELL, P.L.S., MEM. CAN. SOC. C. E., ST. THOMAS, ONT.
UNDER INSTRUCTION FROM THE MINISTER OF AGRICULTURE.

During the past decade there has been a marked improvement in our railways, municipal buildings, country residences and farm buildings, but the question of improving our country roads has not received the attention that its great importance demands. One reason for this is, that attention has been directed principally to the securing of lines of railway throughout the different municipalities. Having now secured the advantage of railways for the shipment of farm produce and the bringing in of farm supplies, it is of the greatest importance that the roads leading to these railways be placed in first-class condition. The benefits to be derived from having good roads to the markets are so numerous and so apparent that little need be said in advocating them. Good roads enable the farmer to market his produce at all times, to take advantage of changes in market prices, and to utilize time that cannot be given to other farm work; they enable him to market his produce and secure his supplies at less expense for hauling, with less wear and tear to vehicles, and with less injury to animals. The improvement of roads results in bringing more closely together the members of the agricultural community, and thereby increases the social intercourse of farmers. In a word, the construction of better roads brings the farmers closer to their markets and closer to one another, the financial, social and moral advantages of which are well understood by all.

The question of how to provide the funds for improving our roads will not be dealt with here; nor will that of the much discussed question of statute labor. These questions must be settled by each

municipality for itself. The intention is to give some information that will enable those having the construction and supervision of roads in charge to undertake and carry out the work on a uniform plan, and in such a manner that money and labor will be expended to the best advantage.

Grades.

The grade of the road is a very important element in its construction and should be decided upon before the other works are commenced. In determining the grade, the necessary fall to carry off the water in the side ditches must be considered. There should be a fall in the ditch of at least 3 inches in 100 feet, and necessarily the road should be on the same grade; aside from this point, the road should be as level as possible. In order to show the advantages of having a road as nearly level as possible, the following table made from experiments by noted Engineers shows the difference of draught on different grades. Call the load which a horse can draw on a level 100.

Then on a grade of	1	in	100	a horse can pull	.....	90
" "	1	"	50	" "	.....	81
" "	1	"	40	" "	.....	72
" "	1	"	30	" "	.....	64
" "	1	"	26	" "	.....	54
" "	1	"	20	" "	.....	40
" "	1	"	10	" "	.....	25

From this table it will be seen that a horse pulling a maximum load on a level can pull only four-fifths as much on a grade of 1 in 50; three-fourths as much in a grade of 1 in 40, and one-fourth as much on a grade of 1 in 10. In determining the grades of roads keep well in mind the following: 1. Never make a road ascend one foot more than is absolutely necessa y. 2. Economy in maintenance depends on easy grades. 3. Hilly roads are full of danger, expensive to maintain, and destructive to horses.

If roads were classified as follows: First. Leading roads, that is roads leading to or connecting cities, towns, villages or principal shipping points. Second. The principal roads contributory to the above. Third. What are called back roads, not much travelled. Then the grade of the first should not exceed 5 feet in 100 feet, the grade of the second should not exceed 7 in 100 and the grade of the third should not exceed 10 in 100.

Any grades steeper than the above should be used only for light driving. Although the above grades should not be exceeded, still it is evident that no fixed gradient can be adopted in all situations; the question of the cost of construction is an item that must be considered. In this Province the road allowances were mostly laid out without considering the practicability or impracticability of constructing roads upon them. Most of those road allowances have been opened and are travelled upon, and it is

not very easy to now change the location of them. The question to be considered is how to make on these lines the best road under the circumstances. Economy of motive power must be carefully considered and also cost of construction. These two in most cases will be antagonistic to each other and the merits of each will have to be weighed and decided upon by the person in charge of the work. Sir John McNeill asserts, that "if a road has no greater inclinations than one in forty there is twenty per cent. less cost for maintenance than where the inclination of the road is one in twenty. The additional cost is due not only to the greater injury by the action of the horses' feet on the steeper gradient, but also to the greater fatigue of the road by the more frequent necessity for sledging or breaking the wheels in descent." John Maclennan for some years president of the Association of Road Surveyors for Scotland says, "Gradients should not exceed one in forty. Easy gradients are preferable to dead levels, securing drier and more compact roads."

Foundations.

The stability and permanence of any structure depends upon its foundation, so it is with roads. A poor foundation will soon make a poor surface; the best material may be used but it will soon get into holes, ruts and depressions if the foundation is bad. One of the main essentials for a good road foundation is thorough drainage both surface and subsoil. It is quite impracticable to construct successfully a good road with any kind of material on a soil that is filled with water having no outlet Therefore, the first thing to be done in making a road after the grade is established, is to remove the water from beneath the roadbed and afford an easy means of its escape from the surface. It is necessary to consider the kind and nature of soil that the road is to be built upon before making provisions for its drainage. Different classes of soil will require different treatment, but in every case it is necessary to thoroughly dry the soil by drainage before proceeding further with the work. Gravels and sands are easily dealt with, as they do not hold water in suspension, but clays and most other soils are more difficult, and it requires care and good judgment in most cases to decide on the best means of removing the subsoil water. If the soil is porous and will not hold the water in suspension, then side drains will be sufficient, but if the soil is retentive or springy, then it is necessary that underdrains should be placed along the road, with cut off drains leading to the side ditches at short intervals. Underdrains are best constructed of field tile three or four inches in diameter, and should be at least two and one-half feet deep from the surface. Sometimes one drain along the centre of the road will be sufficient, but two drains are better, one on each side of the finished roadbed.

The joints of the tile should be close, so as to prevent any of the soil from getting into the drain and they should be filled in with cobble, broken stone, or broken brick, in order to take the soakage from the surface.

Side drains may be constructed open, or where possible it is better to have them also of tile and filled in with stone and gravel.

Fig. 1 shows roadbed with two tile drains, one on each side of the roadbed.

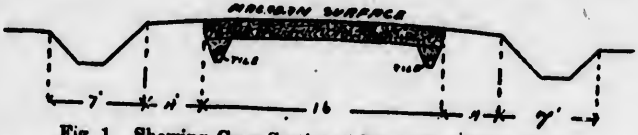

Fig. 1. Showing Cross-Section of Road with Centre Drains.

Fig. 2 shows a section of road with open side drains.

Fig. 2. Cross-Section of Road with Centre Tile Drain.

Fig. 3 shows a section with tile filled in with broken stone and gravel.

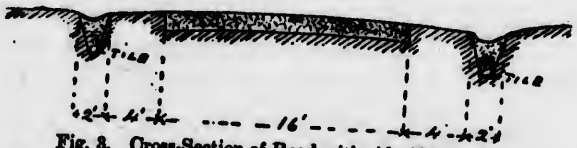

Fig. 3. Cross-Section of Road with side Tile Drains.

Side drains should be at least 3 feet deep from the surface of the road-bed at the centre, and if open, the slope should not be less than 1 to 1, that is, a drain that is 3 feet deep, and 1 foot wide in the bottom, should have a top width of 7 feet. Where they are filled in it is not necessary to have them so wide. Subsoils of runnin sand should always have tile drains, as it is impossible to keep an open drain the necessary depth in such soils.

There is one thing about the uses made of open drains along the side of roads that is very objectionable, that is, they are in a great many cases made the receptacle or outlet for as much of the water as possible of the lands lying adjacent to the road. This, probably is a good thing for the drainage of the lands, but in wet seasons it causes the side drains to be kept continually nearly full of water, which is absorbed by the roadbed to its great injury. Where it is

necessary that a system of drainage, for land purposes only, should be carried along the side of a road, the drain should be carried as near the side of the road allowance as possible, and another drain constructed for road purposes as above described. Our road allowances, which are usually 66 feet, are quite wide enough to have this done.

A uniform and sufficient grade in the bottom of the drains is very desirable, and they should at all times be kept in perfect repair. A little attention for a short time will give the sides a sodded bank which will not cave in or wash away. It is also a good thing to sow the sides of the ditch when completed with grass-seed, and thus hasten the sodding of the banks. Culverts should be put in across the roadbed where necessary, and should be made of cast-iron, stone, or vitrified fire-clay pipe. Cast-iron water-pipe, which will not stand the pressure for waterworks purposes, can generally be obtained at the pipe foundries at a reduced cost; they are coated with a solution of hot tar, will not rust, and are almost indestructible, and make an excellent culvert at a reasonable expense. They are also very easily constructed, no skilled labor being required to put a culvert of this description in place. All that is necessary is to dig the trench for the culvert the necessary depth, put the pipe together in the trench, see that the small end of the pipe is placed the full depth into the hub of the next pipe, fill in the remaining space around the hub with some stiff clay or cement, and then fill in the trench and ram down the earth around the pipe. Pipe can be procured up to 6 feet in diameter.

A few cuts of stone culverts are show in Figs. 4, 5, 6

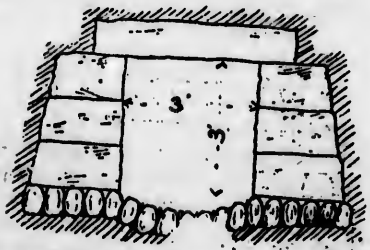

FIG. 4. 3 x3 feet, Box Culvert.

Hard stone that will not absorb moisture is well adapted for the construction of culverts but a great deal more care must be exercised in constructing them than in putting in iron culverts. The foundations must be perfectly solid and secure, and the whole work done in a first-class manner or else the whole structure will sooner or later prove a failure. If the earth foundation is not of a satisfactory description, then concrete or plank should be used to place

the stone work on. If it is for a live stream, plank is the cheapest and will not rot under water. The plank should be placed across the line of the culvert, and extend back on each side the full depth of the walls. To prevent the earth from washing away the bottom, it can be cheaply constructed of cobble-stone, as shown in the cuts. Care must always be taken to prevent the water from getting

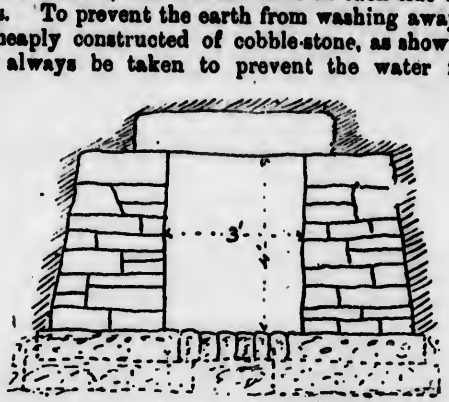

Fig. 5. 3 x 4 feet, Box Culvert.

behind the sidewalls, and where the fall is great, it may be necessary to make an apron of stone at the lower end to prevent the water from washing out the earth after it leaves the culvert. In all cases, unless the stones are large and flat, stonework for culverts should be laid in the best mortar, composed of hydraulic cement and

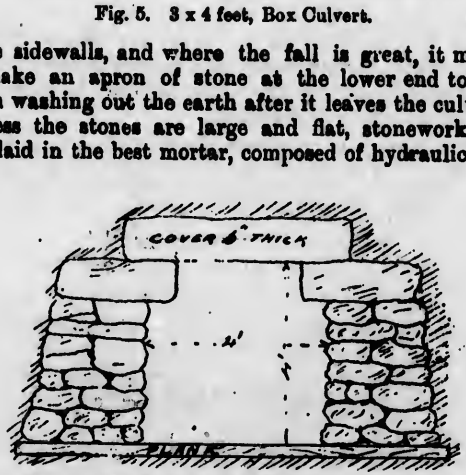

Fig. 6. 4 x 4 feet, Box Culvert.

clean, sharp sand. Larger culverts than shown in the cuts are generally made with an arch, as flagstones larger than shown are not easily procured.

Of late years salt-glazed vitrified sewer-pipe have been largely used for culverts, and if well-laid are well adapted for the purpose.

Care must be taken to make the excavation conform as nearly as possible to the shape of the half of the pipe, with proper depressions for the hubs. The joints should be caulked with clay or cement. If this is not done the water may force itself out of the joints and wash the earth from around the pipe. The earth should be carefully and solidly rammed around the pipe, and the upper surface of the pipe should be at least 15 inches below the surface of the roadway.

The following table shows the size, capacity and price of sewer pipe in car lots at almost any railroad station in Ontario.

Diam. of Pipe, inches.	Capacity, sq. ins.	Weight per foot. lb.	Price per foot. $ c.
6	28	10	13
8	50	16	20
9	63	23	25
10	78	34	30
12	113	44	35
15	177	63	53
18	254	84	80
20	314	100	1 10
24	452	208	1 25

They are now making what is termed "double strength pipes," particularly adapted for culverts; they weigh considerably heavier than the above, and cost about 40 per cent. more per foot.

Drains should be constructed to take the water away freely from the lower end of the culvert, as the freezing of the water in a pipe culvert when over half full is liable to burst it. The use of wood for small culverts is not economical in comparison to culvert pipe; they very soon decay, and are in such cases, to a certain extent, dangerous.

Width of Roadbed.

The width of the roadbed between the side ditches will vary according to the width of metaled surface that is intended to be put upon it, but it should in no case be less than 20 feet (except in fills, which should be fenced). Anything of less width than this, with an open ditch on each side of the road, is somewhat dangerous. Where the metaled surface is to be 16 feet wide, the roadbed should be 24 feet wide, and for a metaled surface of 24 feet the roadbed should be 30 feet wide, unless there is a curb on each side of the metaled portion.

Roadbed.

In preparing the roadbed have all perishable material discarded. The earth taken from the side ditches should be placed upon the roadbed, making the centre higher than the sides and of a convex

form, allowing sufficient for sinkage when rolled; the object of this convex shape is to facilitate the flow of the water into the side ditches. Where the metaled surface is to be of stone a small rise is sufficient, for earth roads it should be more. For stone roads the rise should be about one-fortieth of the width of the roadbed; in gravel roads, one-twenty-fifth, and on earth roads the centre should be at least 1 foot higher than the sides for a 20 foot road. The above will allow for a slight sinkage by travel. The foundation for the metaled portion should be made of the same shape as that intended for the finished surface. It should be well rolled with either a heavy horse or steam roller, and if any depressions are made they should be filled in and it should be again rolled, until it presents a smooth and unyielding surface. It is then in condition to receive the metal surface decided upon.

Material For Road Surfaces.

The chief requisite of a good material for making and repairing roads is, that it should be not only hard, but tough, and that it should be able to stand the wear and tear it will be subjected to, without being crushed by heavy travel. For the best roads the material should be angular and cubical so as to bind well together and leave no space for water to penetrate. The material used will, to a certain extent, depend on the locality, but it is more economical to use the best material even if it has to be brought from a distance. The best material is syenite, basalt, hard volcanic rocks granite or hard limestone; sandstones, slate and all soft rocks make very poor road material and should be avoided. Stones with rounded surfaces should not be used, as they have a tendency to work loose when weight is put upon them.

Opinions vary as to the proper size the fragments should be broken to. The old rule was that all stones should pass freely through a 2½-inch ring. Some engineers advocate weight as a standard, and recommend the following:—Granite and similar rocks, half an ounce to three and a-half ounces; flint and similar stones, three-quarters of an ounce to five ounces; lime-stone and similar stones, one ounce to six ounces; one-half of the above to be of the maximum weight, one-eighth of the minimum weight, and the remainder between the two. There is no doubt that hard and tough rocks should be broken into smaller fragments than soft rocks. The upper surface of the road should have the fragments broken as nearly of a size as possible, and should not be larger than will pass through a 2-inch ring, or smaller than will pass through a 1¼ inch ring. If it is difficult and too expensive too procure all hard rock for the roadbed, then place the softer rock in the bottom and make the surface layer of about 2½ or 3 inches of good wearing material.

Road Surfaces.

Road surfaces outside of pavements may be considered under the heads of Telford, Macadam and Gravel Roads.

Telford Roads. The modern system of making Telford roads differs considerably from that laid down by the inventor, and is practically as follows: On the well-rolled earth foundation, stones about 4 inches wide, 6 inches thick and 8 to 12 inches long are set by hand on their flattest sides, the longest side laid across the road, and in straight rows, the stones to break joint. In the space between the larger stones smaller stones and chippings are firmly wedged, any irregular upper edges of the large stones are sledged off. When finished it presents a slightly roughened surface; this surface should also be well rolled. After the completion of this sub-pavement, at least two separate layers of broken stone are put on. The stones used in the next layer may be from 1 to 3 inches in diameter. This layer should be about 4 inches thick, and should be spread evenly to conform to the finished surface. A small quantity of coarse sand should be spread on this course, sufficient to fill the interstices and act as a binder, and then it should be well and thoroughly rolled after first being sprinkled with water. The top or finished course should be of smaller stone, not over 1½ inches diameter, such as would pass through a 2 inch ring. Great care should be exercised in selecting this layer, as in the quality of the stone depends the life of the road surface. All the stones should be of a uniform size. This course should be at least 3 inches thick, and after being lightly rolled, should be sprinkled with coarse sand or stone screenings from the quarry, watered, and constantly rolled with a heavy roller until it is pressed into a smooth compact mass, so that no more sand or screenings can be pressed into the spaces. In rolling always roll the outside first parallel with the road, working towards the centre. Fig. 7 shows a cross section of Telford roadway for an eight foot surface.

Fig. 7. Section Telford Road Service.

Macadam Roads. In this, as in the former case, modern road builders have departed from the rules laid down by the inventor. Macadam roads are undoubtedly inferior to Telford roads for locomotion where heavy traffic is to be provided for; but, when made care-

fully, are infinitely superior to gravel roads, and are well adapted for rural districts where the travel is not too heavy. In the construction of Macadam roads it is necessary that the earth foundation should be made to conform to the finished shape of the road, it is also of prime importance that the earth foundation should be well rolled and drained. The metaled surface should be put on in three layers, and each layer well rolled; the last two layers should have the necessary amount of binding material, and should be watered as described for Telford roads. All the stone for the first two layers should be cubical in form and should pass through a 2½ inch ring, and in the top course the stone should pass through a 2 inch ring. The metaled surface in a Macadam road need not exceed, when completed, 9 or 10 inches, and in many locations where the traffic is light 6 or 7 inches will be found sufficient. The finished surface should be completed in the same manner as in Telford roads.

In the top course good clean gravel may be substituted for broken stone with very good results.

Fig. 8 shows a cross section of a macadam road.

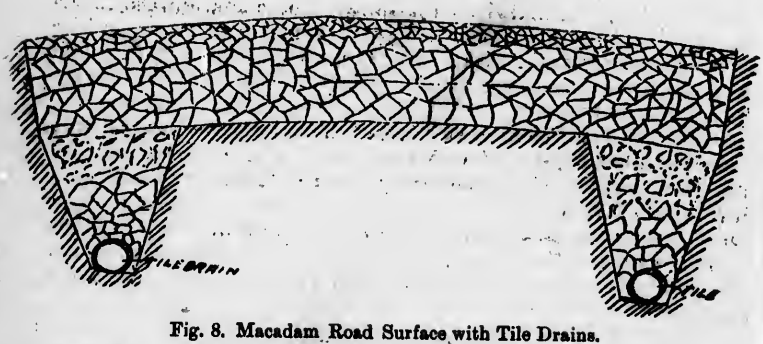

Fig. 8. Macadam Road Surface with Tile Drains.

Gravel Roads. The foundation for gravel roads should be prepared in the same manner and with as great care as that specified for either Telford or Macadam roads. To make a good road of gravel the material must be carefully selected, it should be screened and all stones discarded that will not pass through a 2-inch ring. The large stones afterwards can be broken and used, or they form a first-class material to fill in over the tile drains. Gravel should be put on in two or three layers and each layer thoroughly rolled. The last layer may require a small amount of binding material of course sand in order to make a solid, smooth surface capable of bearing the heaviest loads without cutting or sinking. If the gravel is angular in shape, hard and of uniform size, it will make a hard, durable roadbed.

The usual way adopted in making gravel roads is to grade the road with dump scrapers and, before it has time to get packed by travel, to put on the gravel, a load or a load and a half to every 9 feet; this is heaped in the centre of the road to to a width of about 6 feet, and left in such a condition that it is almost impossible to travel upon it. The consequence is that the travelling public do not attempt to drive on it, but use the sides of the road until they are so cut up as to be impassable. By this means the sides are made into gutters which catch the water and it soaks through the whole roadbed, the result is that the gravel soon disappears and the road is little better than at first. If gravel roads were made on well drained and compact foundations, with the gravel laid in layers, watered and well rolled, they would answer the purpose required of them where the travel is not very great.

The metaled part of a graveled road should not be less than 8 feet wide. In some parts of the Province it is very difficult to get either stone or gravel. In such cases a good substitute for the bottom courses can be made of well burned clay placed on the road in a similar manner. It will not answer so well for the top course, which should be of a hard, well wearing material, either broken stone or gravel, but a road wholly constructed of hard burned clay, on a properly prepared foundation is undoubtedly superior to a mud road and can be built at a reasonable expense.

Earth Roads. A very large proportion of our country roads come under this designation. It is quite unreasonable to urge that all roads should be made of either stone or gravel. Earth roads we have and will have for years to come. The question is, what can we do to make them better? Can they be improved? If so, in what manner? There is no doubt they can be very much improved. They should be drained, graded and rolled with as much care as described for other roads. The grades should be made as even as possible. The crown of the surface should be more than for a stone or gravel road, as they do not shed the water so readily. The roadway should not be more than 20 feet wide, in order to keep the surface as dry as possible. No sods or vegetable matter should be used on the roadbed. Sandy roads can be greatly improved by putting a small quantity of clay on them. It is quite impossible to keep a clay road in good condition during wet weather, but with proper care and attention they can be greatly improved. If they are properly drained, the use of a horse road-machine and roller in the spring as soon as they have dried up, taking care to scrape from the outsides to the centre, will place them in good condition for the summer months.

Repairs and Maintenance.

When a road is completed and open for traffic, it should not be left to itself, but should be carefully watched, and if it shows any signs of settling, giving way, or working into holes, it should be attended to at once, otherwise it will soon deteriorate. There is no doubt that a road properly built in every particul should wear evenly, but the great trouble is to get a perfectly uniform hardness of metal and every part of the work done with exactly the same care. If there is a weak spot in any part of the work it will soon show itself after the heavy travel gets upon it, and as soon as it does, it should immediately be repaired. Always, in repairing a depression or hole in a road, use as nearly as possible the same kind of material that was used for surfacing the road. Clean out any mud that may be in the part to be repaired, loosen the surface over which the repairs are to extend with a pick, in order to secure a bond with the old bed, and put just sufficient material on the place so that when rolled or properly pounded it will be even with the surface at each side. When the thickness of the bed becomes so reduced that it is necessary to have it remetaled, let it be done in sections Before putting on new material, the surface should be picked up a little to allow the new material to bind well into the old, then the new metal should be laid, spread, wetted and rolled in the same manner as described for building the road. Repairing material should be placed at intervals along the side of the road so as to be convenient for use when required. The following instructions were published by the Road Improvment Association of London, England, for the use of their roadmen, they are well worth repeating. They are intended to apply only to Macadam and Telford roads :

1. Never allow a hollow, a rut, or a puddle to remain on a road, but fill it up at once with chips from the stone heap.
2. Always use chips for patching and for all repairs during the summer months.
3. Never put fresh stones on the road, if by cross-picking and a thorough use of the rake the surface can be made smooth and kept at the proper strength and section.
4. Remember that the rake is the most useful tool in your collection and it should be kept close at hand the whole year round.
5. Do not spread large patches of stone over the whole width of the road, but coat the middle or horse track first and, when this has worn in, coat each of the sides in turn.
6. In moderately dry weather and on hard roads always pick up the old surface into ridges six inches apart, and remove all large and projecting stones before applying a new coating.
7. Never spread stones more than one stone deep, but add a second layer when the first has worn in, if one coat be not enough.
8. Never shoot stones on the road and crack them where they lie, or a smooth surface will be out of the question.
9. Never put a stone upon the road for repairing purposes that will not freely pass in every direction through a 2-inch ring, and remember that still smaller stones should be used for patching and for all slight repairs.

10. Recollect that hard stones should be broken to a finer gauge than soft, but that the 2-inch gauge is the largest that should be used under any circumstances, where no steam roller is employed.

11. Never be without your ring gauge, remember Macadam's advice that any stone you cannot put easily in your mouth should be broken smaller.

12. Use chips, if possible, for binding newly laid stones together, and remember that road sweepings, horse droppings, sods or grass, and other rubbish, when used for this purpose, will ruin the best road ever constructed.

13. Remember that water-worn or rounded stones should never be used upon steep gradients, or they will fail to bind together.

14. Never allow dust or mud to lie on the surface of the roads, for either of these will double the cost of maintenance.

15. Recollect that dust becomes mud at the first shower and that mud forms a wet blanket which will keep a road in a filthy condition for weeks at a time, instead of allowing it to dry in a few hours.

16. Remember that the middle of the road should always be a little higher than the sides, so that the rain may run into the side gutters at once.

17. Never allow the water-tables, gutters and ditches to clog up, but keep them clear the whole year through.

18. Always be on your road in wet weather and at once fill up with "chips" any hollows or ruts where the rain may lie.

A perfectly good road should always present a firm, dry, smooth and compact surface, free from ruts, hollows, or depressions. The surface should neither be too flat to allow water to stand on the road, nor too rounding to be inconvenient to the traffic. The surface should be so constructed that the water cannot penetrate it from above nor the water and dirt from below.

Improvement of Existing Roads.

There are in nearly every township in the Province, roads upon which a considerable amount of money has been spent in the way of reducing grades and putting on gravel.

Such roads in summer time are generally in fairly good condition, but in fall, winter and spring they get badly cut up into ruts and holes, and it will be noticed that in the spring when the frost is coming out of the ground, they are in their worst condition, "they have been heaved by the frost" and in a great many places the wheels of the vehicles will cut through into the subsoil. Now the condition described is caused mainly by lack of proper drainage; when there is thorough drainage of the roadbed heaving by frost will not occur; if there is no water in the roadbed the frost has nothing to act upon and will do no damage. Another great cause of injury to roads of this description, indeed to all our roads, is that nearly all repairs are made to them in the early part of the year, and in the fall there is no money left with which to make repairs. The statute labor has been put in, grants for repairs have been exhausted, and, if it be a wet fall, the roads get into very bad condition. They get cut up into ruts and holes, fill with water and freeze, and probably remain in that condition until spring. Is it any wonder then, with water underneath and holes and ruts full of water above, that some of our best roads become almost impassable in the spring, and

remain so until they become dry enough to get a road machine or scraper of some kind to evel them up. By the exercise of a little attention and good judgment and at a small expense, roads like the above could be radically changed for the better.

Before any more surface material is placed on such roads see that the side drains are opened so that no water will remain within two feet of the surface, and also that all subsoil water is removed. If centre drains are required, dig a ditch on each side of the gravelled surface and put in tile drains as before described, with cross drains into the side ditches every 200 or 300 feet. Have the road surface made sufficiently convex to shed the water rapidly to the side ditches, and clean off all the mud from the road surface. Money spent in this way will give good results. Money spent on the road without first doing this, will, to a large extent, be wasted.

If the roadbed requires a new coating of surface material after being properly drained and rounded up, it should be put on evenly with the best gravel obtainable and thoroughly rolled to a smooth hard surface. Annual repair of roads, or the repair of roads only once a year is wrong in principle. They should be repaired at all times whenever they show signs of giving away, and for that purpose a certain amount of material should always be kept on hand along the road side at convenient intervals to make repairs when required.

Tires.

The width of tires on vehicles has a great deal to do with the destruction of our roads. The great defect is, that for heavy loads the tires are too narrow. It has been proved by repeated and careful experiments that wheels with tires 2½ inches wide cause double the wear of wheels which have tires 4½ inches wide. The surface of the roadway is not able to bear the heavy load put upon it by narrow tires, the tire therefore cuts through the surface and forms deep ruts.

The following extract is taken from a report of experiments made by the Professor of Agriculture of Missouri to ascertain just what the difference is between the force required for pulling a load of given weight over different kinds of roads and to show the value of broad tires: "The wheel tires were respectively 1½ inches and 3 inches wide, and the trial was on a partially dried mud road. The load was in each case 3,695 pounds. The draft for the broad tires was 371 pounds and for the narrow 441 pounds, and the broad tires cut the road less deeply than the narrow ones." In the care of our gravel or stone roads the good effect of broad tires would probably be even more noticeable than on mud roads, especially in the matter of keeping the road surface compact.

The width of tires on wheels should be properly proportioned to the weights they are designed to carry. Wide tires have a tendency to roll the road and keep it smooth at the same time, usually it does

not require the same amount of force to haul a vehicle with wide tires as it does to haul one with narrow ones. Municipalities should consider the regulating of traffic in this regard.

Most of the European countries have laws regulating the width of tires on vehicles. In France the market wagons have tires from 3 to 10 inches in width, usually from 4 to 6 inches. Not only have they wide tires but in most of their four wheeled freight wagons the rear axle is 14 inches longer than the fore axle, so that the rear wheels run on a line about an an inch outside of the line of the fore wheels; instead of being a road destroyer they are a veritable road maker.

The following width of tire to load may be recommended:

Load on each wheel.	Wagon without springs.	Wagon with springs.
500 lb. to 1,000 lb.	2½ inches.	1½ inches.
1,000 " 1,500 "	3 "	2 "
1,500 " 2,000 "	4 "	3 "
2,000 " 3,000 "	6 "	4 "

In order to encourage the use of wide tires in the State of Michigan they have a law granting a certain reduction in taxes to those who use wide tires.

Vehicles on springs are much easier on roads than vehicles without springs.

Wheels of large diameter do less damage to roads than smaller ones and cause less draught.

Road Machinery.

Machinery for road making effects a great saving in the expense of making and repairing roads, besides doing the work in much shorter time. Every municipality should have a sufficient number of road machines or graders to assist in keeping their roads in a proper state of repair and to construct new roads when required. There are various kinds on the market, mostly made of steel, and if used properly will pay for themselves in one season. Each municipality should also have either a horse or steam roller. A good horse roller is preferred for general road work; it should weigh about 3 tons and be so constructed that it could be weighted to 7 or 8 tons by stones or pig iron. The advantages of a light roller are, that in rolling soft material it will not stick, or push the material in advance of the roller, and when the bed is rolled with the light roller and becomes hard and smooth, weight can be added to the roller to any desired extent. These rollers should be made so that the tongue could be reversed from one side of the roller to the other, thus preventing turning around at the end of the stretch. Such a roller as the above can be purchased for $200, and its value in making and maintaining roads cannot be estimated.

Another machine that is necessa. for any municipality building stone roads is a stone crusher. Throughout the Province, in almost every township, are found numbers of boulders, usually termed "hard heads." They nearly all consist of excellent material for making good roads if broken. They have generally no commercial value, and with the aid of a stone crusher could be utilized in improving our road system. If the stone has to be transported a distance from the quarry, then the crusher should be placed at a point along where the road is to be constructed. This will be found more convenient than hauling the crushed stone a long distance. Besides the above, there are various other labor-saving machines which can be used to advantage when occasion requires, such as wheeled scrapers, dump scrapers, sweepers, etc., but the above mentioned machines should be in the possession of every municipality that desires to construct and repair its roads in an economical manner. The writer knows of municipalities that have recently purchased and operated road machines in the improvement of their roads, and the result has been a marked improvement in the state of their highways.

Road Sides.

A word for the road sides: How often the following is to be seen along the sides of the roadways in the country: Stumps and stones taken from the adjoining fields and piled along the fence, brush from the orchards, weeds from the gardens, saw logs and wood piled up to be taken to market when convenient, and weeds of every description allowed to grow.

The farmer who prides himself on the neatness and cleanliness of his farm, has just reason to protest against the roadway being used as a dumping place for the refuse of the farm or a storage place for logs and wood, or as a place in which foul weeds may mature their seeds to his injury.

Every traveler using the roadway has a right to protest against its being defaced in this manner, as it destroys a great deal of the pleasure that would be experienced were it kept in a proper state. Nothing should be placed on the roadway that will mar the view. A well-kept farm does not appear to advantage beside a badly kept roadway. There should be as much thought and care given to improving the appearance of our roads as a good surface.

The sides should be levelled and graded so that they will present a smooth and sightly appearance. Trees should be planted along the roadsides and the whole kept in a proper state of repair, and everything done to make its appearance as pleasing as possible. By doing this it will not only add to the greater pleasure to be derived in travelling, but will improve both the appearance and the value of the farms along the roadway.